

**B.Sc. CHEMISTRY
THIRD SEMESTER
PHYSICAL CHEMISTRY- II
BSC – 301 [REPEAT]
[USE OMR FOR OBJECTIVE PART]**

**SET
A**

Duration: 3 hrs.

Full Marks: 70

Time: 30 min.

(Objective)

Marks: 20

Choose the correct answer from the following:

1X20=20

- The relation between enthalpy, entropy and Gibb's free energy is
 - $\Delta G = \Delta H - T\Delta S$
 - $\Delta H = \Delta G - T\Delta S$
 - $\Delta G = \Delta H + T\Delta S$
 - None of the above
- A process is said to be spontaneous if
 - $\Delta G < 0$, $\Delta H = -Ve$, and $\Delta S = -Ve$
 - $\Delta G < 0$, $\Delta H = -Ve$, and $\Delta S = +Ve$
 - $\Delta G = 0$, $\Delta H = -Ve$, and $\Delta S = -Ve$
 - None of the above
- The relation between Gibb's free energy and Helmholtz free energy is
 - $\Delta G = \Delta A + P\Delta V$
 - $\Delta A = \Delta U - T\Delta S$
 - $\Delta A = \Delta G + P\Delta V$
 - $\Delta G = \Delta H - T\Delta S$
- Standard enthalpy of a reaction is determined at
 - 298 K and 1 atm pressure
 - 25 K and 1 atm pressure
 - 25°C and 1 bar pressure
 - 25 K and 1 bar pressure
- Freundlich adsorption isotherm is given by the expression $x/m = kp^{1/n}$, which of the following conclusions can be drawn from this expression
 - When $1/n = 1$, the adsorption is directly proportional to pressure
 - When $1/n = 1$, the adsorption is independent of pressure
 - When $n = 0$, plot of x/m vs p is a curve
 - None of the above
- The correct option representing a Freundlich adsorption isotherm is
 - $\frac{x}{m} = k p^{-0.3}$
 - $\frac{x}{m} = k p^{2.5}$
 - $\frac{x}{m} = k p^{0.5}$
 - $\frac{x}{m} = k p^{-1}$
- A monoatomic gas, X, adsorbed on a surface, follows Langmuir adsorption isotherm. A plot of the fraction of the surface coverage, θ against the concentration of the gas [X], for very low concentration of the gas is described by the equation,
 - $\theta = K[X]$
 - $1 - \theta = 1 / K[X]$
 - $\theta = K^{1/2} [X]^{1/2}$
 - $\theta = K[X] / (1 + K[X])$
- The criterion for the spontaneity of a process is
 - $\Delta S_{sys} > 0$
 - $\Delta S_{surr} > 0$
 - $\Delta S_{sys} + \Delta S_{surr} > 0$
 - $\Delta S_{sys} - \Delta S_{surr} > 0$

9. If a non-volatile solute is added to a solvent, vapour pressure
 - a. Increases
 - b. Decreases
 - c. Remains same
 - d. Becomes zero
10. Boiling point of solution compared to pure solvent is:
 - a. Lower
 - b. Higher
 - c. Same
 - d. Variable
11. Which property is used to determine molar mass of polymers?
 - a. Osmotic pressure
 - b. Boiling point elevation
 - c. Freezing point depression
 - d. Vapour pressure lowering
12. For non-ideal solutions showing positive deviation, ΔH_{mix} is:
 - a. Zero
 - b. Negative
 - c. Positive
 - d. Infinite
13. Molality is independent of
 - a. Temperature
 - b. Solvent mass
 - c. Solute moles
 - d. Pressure
14. Relative lowering of vapour pressure is equal to:
 - a. Mole fraction of solute
 - b. Mole fraction of solvent
 - c. Molality
 - d. Molarity
15. The pH of an aqueous solution of sodium acetate is:
 - a. 7
 - b. Less than 7
 - c. Greater than 7
 - d. 0
16. The hydrolysis constant (K_h) of a salt of weak acid and strong base is given by:
 - a. $K_h = K_w / K_a$
 - b. $K_h = K_w \times K_a$
 - c. $K_h = K_a / K_w$
 - d. $K_h = K_w / K_b$
17. According to Le Chatelier's principle, if temperature is increased in an exothermic reaction, the equilibrium will:
 - a. Not change
 - b. Shift to the right
 - c. Shift to the left
 - d. Stop completely
18. For the equilibrium

$$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g) + \text{heat}$$
 What happens if pressure is increased?
 - a. The equilibrium shifts to the right
 - b. The equilibrium shifts to the left
 - c. No change
 - d. Reaction stops
19. The solubility product (K_{sp}) of AgCl is 1.0×10^{-10} at 25°C . The solubility of AgCl in pure water is:
 - a. $1.0 \times 10^{-5} \text{ mol L}^{-1}$
 - b. $1.0 \times 10^{-10} \text{ mol L}^{-1}$
 - c. $1.0 \times 10^{-4} \text{ mol L}^{-1}$
 - d. $1.0 \times 10^{-2} \text{ mol L}^{-1}$
20. If 100 mL of 0.1 M NaOH is added to 100 mL of 0.1 M HCl, the resulting pH is:
 - a. 7
 - b. 0
 - c. 14
 - d. 12

(Descriptive)

Time : 2 hrs. 30 min.

Marks : 50

[Answer question no.1 & any four (4) from the rest]

1.
 - a. Establish the relation between Gibb's free energy and Helmholtz free energy. 2+2+1+2
+3=10
 - b. Explain graphically the variation of Adsorption isobar for physisorption and chemisorption.
 - c. Write the equation for multilayer adsorption isotherm process.
 - d. A 25.00 mL sample of sulfuric acid solution requires 18.00 mL of 0.200 N NaOH for complete neutralization. What is the normality of the H_2SO_4 solution?
 - e. Derive the expression for the solubility of a salt of type AB_2 and A_2B_3 in terms of its solubility product constant.
2.
 - a. What is thermochemistry? Write about the enthalpy of formation and enthalpy of combustion. Explain with examples. 3+3+2+2
=10
 - b. Derive the Kirchhoff equation for variation of enthalpy of a reaction with temperature?
 - c. Explain the Hess's law and its application.
 - d. What is flame and explosion temperature?
3.
 - a. Why the adsorption process occurs? Explain. 2+2+2+2
+2=10
 - b. What is the role of adsorption in heterogeneous catalysis?
 - c. Explain graphically the variation of adsorption isotherm at three different temperature (T_1 , T_2 and T_3 when $T_1 > T_2 > T_3$).
 - d. What are the limitations of Freundlich Adsorption isotherm?
 - e. At low pressure and high pressure, how the surface coverage is related to the pressure. Explain mathematically.
4.
 - a. Write the postulates of Langmuir Adsorption isotherm. 2+3+2+3
=10
 - b. The adsorption of a gas is described by Langmuir adsorption isotherm with the equilibrium constant $k = 0.9 \text{ K.Pa}^{-1}$ at 25°C . Calculate the pressure in K.Pa at which fractional surface coverage is 0.95.

- c. Derive the relation $S = -\left(\frac{\partial G}{\partial T}\right)_p$
- d. Derive the Gibbs-Helmholtz' equation.
5. a. Deduce the thermodynamic derivation of elevation of boiling point (ΔT_b)? 3+2+3+2
=10
- b. What is the relationship between latent heat of fusion and molal depression constant? Calculate the molal depression constant for water as solvent.
- c. The osmotic pressure of an aqueous solution of a protein containing 0.63 g of a protein in 100 g of water at 300 K was found to be 2.60×10^{-3} atm. Calculate the molar mass of the protein. $R = 0.082 \text{ L atm K}^{-1} \text{ mol}^{-1}$
- d. Discuss the positive deviation of Raoult's Law.
6. a. The relative lowering of vapour pressure produced by dissolving 7.2 g of a substance in 100 g water is 0.00715. What is the molecular mass of the substance? 3+2+2+3
=10
- b. Deduce the relationship between Relative lowering of vapour pressure and Osmotic Pressure.
- c. Write the Vant Hoff's Avogadro's Law for osmotic pressure with expression.
- d. The boiling point of benzene is 353.23 K. When 1.80 g of a non-volatile solute was dissolved in 90 g of benzene, the boiling point is raised to 354.11 K. Calculate the molar mass of the solute. K_b for benzene is $2.53 \text{ K kg mol}^{-1}$
7. a. Calculate K_c for the reaction $2\text{SO}_3(\text{g}) \rightleftharpoons 2\text{SO}_2(\text{g}) + \text{O}_2(\text{g})$ for which $K_p = 3.5 \times 10^{-23} \text{ atm}$ at 27°C . 3+3+3+1
=10
- b. Explain the effect of pressure on the freezing point of water and sulphur based on Le Chatelier's principle.
- c. The equilibrium constant K_p for the reaction $\text{H}_2(\text{g}) + \text{S}(\text{g}) \rightleftharpoons \text{H}_2\text{S}(\text{g})$ is 20.2 atm^{-1} at 945°C and 9.1 atm^{-1} at 1065°C . Calculate ΔH° .
- d. State Le Chatelier's principle.

8. a. A solution of 0.1M CH_3COOH is found to be dissociated to the extent of 1.33 % at room temperature. Calculate the dissociation constant of the acid at this temperature.
- b. 25 ml of 0.1 M CH_3COOH is titrated against 0.1 M NaOH . Calculate the pH value of the titration solution after addition of 25 ml of NaOH solution.
- c. Calculate the pH of a buffer solution of 0.1M CH_3COOH and 0.1M CH_3COONa . K_a for CH_3COOH 1.75×10^{-5} .
- d. Explain the action of Phenolphthalein as indicator.
- e. Explain the relationship between the solubility product (K_{sp}) and the ionic product (Q) in determining whether a precipitate will form.

2+3+2+2
+1=10

= = *** = =